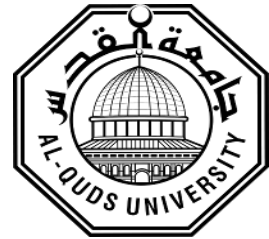


Al –Quds University

Deanship of Graduated Studies



**"The effects of Electronic waste burning on lead concentration in water
and blood in Biet Awwa village"**

Mohammed Adel Mohammed Tahayneh

M.Sc. Thesis

Jerusalem-Palestine

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**The effects of Electronic waste burning on lead concentration in water
and blood in Biet Awwa village**

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**A Thesis Submitted in Partial Fulfillment of the Requirement for the
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Deanship of Graduated Studies

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School of Public Health



Thesis approval

"The effects of Electronic waste burning on lead concentration in water and blood in Biet Awwa village"

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Declaration

I certify that this thesis submitted for the degree of Master is the result of my own research, except where otherwise acknowledged and that this thesis (or any part of the same) has not been submitted for a higher degree to any other university or institution.

Signed:**Mohammed Adel Tahayneh****Date** 15/8/2016

Dedication

To my father, Adel Tahayneh

To my mother, Suhad Tahayneh

To my grand father

To my grand mother

To my aunti Najeyah

To my darling wife, Ala

To my well-regarded sisters and brothers, and

To those who treasured Palestine as a home and land

To my supervisor Dr. Akram Amro

To everyone who helped me, specialized engineer Hadeel Tamemi, Mrs. Ruba dwaik, Mr. Issa Ghrouz, Mr. Ibrahim Abu Al Wafa and Mr. Mohammed Kmail

Mohammed Adel Tahayneh

ABSTRACT

Background

Burning of electronic waste constitutes a major public health problem in Beit Awwa village. Recurrence of electronic waste burning may lead to dangerous health problems in the Palestinian society there, especially in the areas in which electronic waste burning is prevalent. This burning often has impact on the citizens who live in these areas. It is so important to highlight the damage and risks that burning of electronic waste burning has on the human health in this area.

Study Methodology

This descriptive comparative study aims at measuring the concentration of lead in the human blood, as well as measuring the concentration of lead in water springs that results from burning of electronic waste in Beit Awwa region- Southern Hebron Governorate- and comparing it with the town of Halhoul in which there is no burning of electronic waste. One hundred and four samples were taken, distributed equally between the two regions.

Results

Results showed that 39% of those participating in the study supported the statement that burning of electronic waste directly has an impact on home water that comes from the municipality while 55% did not support this. Moreover, 55% agree that burning of electronic waste has impact on home water that comes from natural water resources. 69% do not think that burning affects the taste of water, while 72.2% did not think that such burning affects the smell of water.

The study diagnosed that the concentration of lead quantity in the water springs in the regions that are exposed was higher than that in those regions that are not exposed. The mean in the exposed regions was (3.30PPb), while in the regions that are not exposed the mean was (2,74PPb). SD in the regions that are

exposed was (6.80PPb) while it was (5.08) in the regions that are not exposed . The mean in the exposed regions was (1.7PPb) while in the regions that are not exposed it was (2.1PPb). SD in the target regions was lower compared with the regions that are not targeted with regard to home water. SD was (1.7PPb) and (2.1PPb) in the exposed and none exposed regions respectively.

Results showed that the concentration of lead in the blood is higher by 5% in the regions in which electronic waste is burned. In the exposed regions it was (42.24PPb) while in the none exposed regions it was (38.12PPb). The Mean in the former regions was (54.94PPb) while in the latter it was (94.87).

Results diagnosed that the concentration of lead in the blood of those who work in burning of electronic waste was (55PPb) while it was (39PPb) in the blood of those who do not work in such burning.

Results showed that the hemoglobin in blood in the none exposed regions was higher than that in the exposed regions. The Means in the exposed and none exposed regions were (11.28PPb) and (12.19PPb) respectively.

Conclusions and Recommendations:

The study concludes that burning of electronic waste has impact on human health and natural resources (water springs) that exist in the regions in which electronic waste is burnt. It also concludes that there exists an extra amount of lead in human blood and water springs, resulting from such burning, which may cause several dangerous diseases that have impact on human health.

Therefore, upgrading knowledge and education about the damages and impact of burning of electronic waste on human health are considered the first step in overcoming this problem. Moreover, competent governmental bodies and exposed. Conclusion: Burning affects both health and environment, measures should be taken to stop the burning in order to mitigate the environmental and health lead -related problems in Beit Awwa .

العنوان: تأثير حرق النفايات الالكترونية على نسبة الرصاص في الماء والدم في بلدة بيت عوا .

إعداد الطالب: محمد عادل محمد طحaine

إشراف: الدكتور أكرم عمرو

ملخص الدراسة:

الخلفية: يشكل حرق النفايات الالكترونية مشكله مهمة في الصحة العامة في منطقة بيت عوا. إن تكرار حرق النفايات الالكترونية قد يؤدي إلى مشاكل صحية خطيرة في المجتمع الفلسطيني المتنامي وبالذات في المناطق التي يكثر فيها حرق النفايات الالكترونية. حيث أن هذا الحرق يكون مؤثرا على المواطنين الساكنين في تلك المناطق غالبا. من المهم جدا أن يتم إظهار أضرار ومخاطر حرق النفايات الالكترونية على صحة الإنسان في تلك المنطقة.

منهجية الدراسة: تهدف هذه الدراسة الوصفية المقارنة إلى قياس كمية الرصاص في دم الإنسان وقياس نسبة الرصاص في ينابيع المياه الناتج عن حرق النفايات الالكترونية في منطقة بيت عوا -جنوب محافظة الخليل-فلسطين ومقارنتها مع مدينة حلحول التي لا يوجد فيها حرق للنفايات الالكترونية. تم أخذ 104 عينة موزعة مناصفة على المنطقتين.

النتائج:

أظهرت النتائج أن 39% من المواطنين المشاركين في الدراسة يؤيدون أن حرق النفايات الالكترونية يؤثر بشكل مباشر على المياه المنزلية التي تأتي من البلدية، وأن نسبة 55% لا يؤيدون ذلك. وأيضاً 55% يؤيدون أن حرق النفايات الالكترونية تؤثر على المياه المنزلية التي تأتي من مصادر المياه الطبيعية. 69% لا يعتقدون أن حرق النفايات الالكترونية يؤثر على طعم المياه، ونسبة 72.2% لا يؤيدون أن حرق النفايات الالكترونية قد يؤثر على رائحة المياه.

شخصت الدراسة أن كمية الرصاص في ينابيع المياه في المناطق المعرضة كانت أعلى منها في المناطق غير المعرضة، حيث كان المتوسط الحسابي في المناطق المعرضة (3.30) و (2.74) في المناطق غير

المعرضة، وكانت قيمة الانحراف المعياري في المناطق المعرضة (SD= 6.80)، وفي المناطق غير المعرضة (SD=5.08).

بينما كانت قيمة المتوسط الحسابي في المناطق المعرضة (1.7) و (2.1) في المناطق غير المعرضة الانحراف المعياري أقل في المناطق المستهدفة مقارنة بالمناطق غير المستهدفة بالنسبة للمياه المنزلية، و كان الانحراف المعياري في المناطق المعرضة (SD= 1.7) وفي المناطق غير المعرضة (SD=2.1).

أظهرت النتائج أن كمية الرصاص في الدم أعلى بنسبة 5% في المناطق التي يتم فيها حرق النفايات الالكترونية، حيث كانت كمية الرصاص في الدم في المناطق المعرضة (42.42) بينما في المناطق غير المعرضة (38.12).

شخصت النتائج أن كمية الرصاص في الدم لدى العاملين في حرق النفايات الالكترونية هي (55PPb) مقارنة بنسبة (39PPb) لدى غير العاملين بحرق النفايات الالكترونية.

بينت النتائج أن كمية هيموغلوبين الدم في المناطق غير المعرضة أعلى منه في المناطق المعرضة، المعرضة. حيث كان المتوسط الحسابي في المناطق المعرضة (11.28) وفي المناطق غير المعرضة (12.19).

الاستنتاجات والتوصيات: تستنتج هذه الدراسة أن حرق النفايات الالكترونية يؤثر على صحة الإنسان، وعلى الموارد الطبيعية (ينابيع المياه) الموجودة في المناطق التي يتم فيها حرق النفايات الالكترونية. ووجود كمية زائدة من معدن الرصاص في دم الإنسان وفي ينابيع المياه الناتج عن حرق النفايات الالكترونية قد يؤدي إلى حصول أمراض متعددة وخطيرة تؤثر على صحة الإنسان.

وبناء عليه فإن تحسين المعرفة والتثقيف الصحي حول أضرار وتأثير حرق المحروقات الالكترونية على صحة الإنسان يعتبران الخطوة الأولى للتغلب على هذه المشكلة .

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Abbreviations

E-waste: Electronic waste

T.V: Television

Pb: Lead

WHO: World Health Organization

PVC: Polyvinyl chloride

IQ: Intelligence quotient

PPb: parts per billion

BLL: Blood lead levels

µg/Dl: Micrograms per deciliter

IgA: Immunoglobulin A

IARC: International Agency for Research on Cancer

CKD: Chronic Kidney Dysfunction

SD: Standard Deviation

R: spearman Correlation

df: Degree of Freedom

ICP- MS: Inductively coupled plasma mass spectrometry

Ppt :Part per trillion

ORS: Octapole Reaction System

Hb: Hemoglobin

CBC: Complete Blood Count

Chapter One

1.1: Introduction.

Electronic-waste (e-waste) is a collective name to all electronic devices which have been expired of their useful life period like discarded computers, computer peripherals, mobile phones, televisions, and others. E-waste has increased the total waste volume and after dismantling and burning, it releases various toxic and carcinogenic gases and metals which are posing a threat to human health and also contaminate the environment (Kowsaretal. 2010).

E-waste has been a problem of great concern not only for the government but also for the public due to their hazardous material contents (Cui and Forssberg, 2003; Liu,et al. 2008).

Beit Awwa is considered the main Hub for processing of e-waste produced in south west Bank, It is not only the locally generated waste but also include e-waste coming from other parts of 1948 occupied territories. The processing of this e-waste includes dismantling, fragmentation, and burring of the cables to harvest precious metals like copper. One of the main pollutants coming out of burring of this e-waste is the increased lead concentration, which has a variety of health damaging effects on humans and environment.(Pinto, 2008)

1.2: Research Problem.

Informal e-waste recycling includes the dismantling of end-of-life electronics to retrieve valuable elements with primitive techniques, without or with very little technology to minimize exposure or protective equipment, allowing the emission of dangerous chemicals (Wong, 2007). Formal e-waste recycling facilities use specifically designed equipment to safely remove recyclable materials from obsolete electronics while protecting workers from adverse health effects. workers at formal or semiformal recycling centers are still at risk of exposure at low doses of heavy metals toxicity (Yu, and Wong, 2006).

Because of the high levels of environmental, food, and water contamination, residents living within a specific distance of e-waste recycling areas are also at risk of environmental exposure, although at lower levels than through occupational exposure (Schluep, 2010).

In Palestine, there is a lack of information about the effect of this informal business of e-waste processing and mainly burning on population health. Represented in the possibility of increased heavy metals concentrations in blood (which some of them are carcinogenic) , specially lead, that had not been studied in that area.

As the majority of e-waste burning activities are taking place in Beit Awwa village, This study is trying to measure the effect of E-waste burring on level of lead concentration in blood and water samples from springs, at the same time studying the hemoglobin concentrationin this village .

1.3 Conceptual Framework

As shown in figure 1.1 , this study is focusing on the outcome of processing of the e-waste coming from 1948 occupied territories and being burned in the village of Beit Awwa .

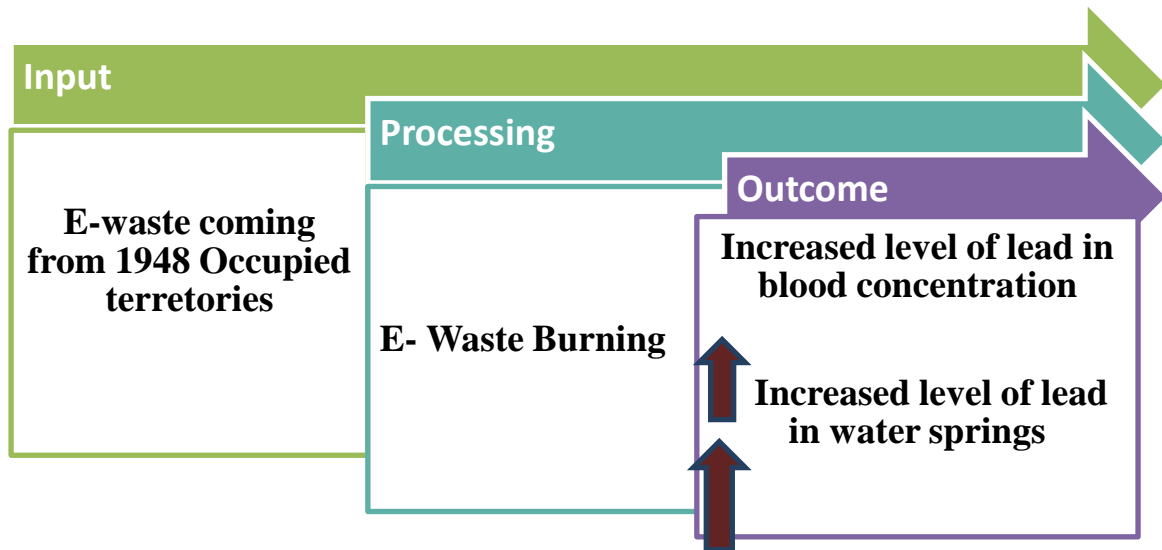


Figure (1.1):e-waste conceptual framework

1.4: Objectives of the study:

1. To measure the level of lead concentration in water springs resources in exposed and non- exposed areas.
2. To measure the level of lead concentration in the blood in exposed and non-exposed areas.
3. To measure the hemoglobin level in exposed and non-exposed areas

1.5: Hypothesis of the study:

There is high blood lead concentration in exposed area when compared to non-exposed area.

There is high water concentration of lead in the exposed area, as compared to non-exposed.

There is high incidence of anemia in the exposed area as compared to non-exposed.

1.6 Significance of the study

The results of this study will highlight the health risks of e-waste disposal and e-waste burning in the target area, which may underline the importance of a national plan for proper healthy disposal and management of e-waste, towards better health protection of the population and the environment in the targeted area.

Chapter Two: Literature Review

2.1. Introduction

E-waste is becoming a major global problem because of two primary characteristics. First, waste is hazardous, containing various toxic substances that cause health damage and serious pollution upon disposal. Second, there is rapid generation of e-waste due to low initial cost and higher disposal rate. When new models of computers, stereos and televisions are produced, the old ones are discarded, as in India alone, in 2010 there was an 0.4 million tons of e-waste produced that is expected to raise to 0.5 and 0.6 in 2013 and 2014 respectively (Needhidasan, et al. 2014).

2.2 Components of e waste in different appliances .

The chemical composition of e-waste depends on the type and the age of the electronic object discarded. It is usually predominated by several metal mixtures, especially copper(Cu),aluminum(Al)and iron(Fe)attached to, covered with, or mixed with several plastics or ceramics, such as heavy metals, are used in the production of electronic items, while others such as polycyclic aromatic hydrocarbons (PAHs) are produced by burning e-waste at low temperatures burning, which are considered as metals of concern due to their toxicity (Christian2006). Burning the isolating plastic cable coversine open barrels produces 100 times more dioxins than domestic waste burning (Liu et al, 2008). As shown in Table 2.1that there are many heavy metals that may be released from the process of e-waste management worldwide .

Table 2.1 Potential environmental pollutants produced from e-waste management procedures (Gaidajis, et al ,2010)

substance	Occurrence in e-waste	Typical concentration in mg/kg	Global emission
PCB	Condensences, transformers	14	280
Lead	PbCRT screens	2900	58000
Cadmium	Batteries, printer ink toners	180	3600
Chromium	Floppy disks	9900	198000

2.3 Potential pollution outcome of e-waste negative processing

The processes of dismantling and disposing of e-waste lead to a number of environmental effects as shown in Table(2.2). Liquid and atmospheric emissions end up in bodies of water, groundwater, soil and air, and subsequently in domestic and wild land and sea animals, crops consumed eaten by animals and humans, and in drinking water.

Table (2.2) Environmental pollution of the processing of various electronic waste components(Pinto, 2008)

E-Waste Component	Process Used	Potential Environmental Hazard
Cathode ray tubes (used in TVs, computer monitors, ATMs, video cameras and more)	Breaking and removal of yoke, then dumping	Lead, barium and other heavy metals leaching into the ground water and release of toxic phosphor

Printed circuit boards (image behind table - a thin plate on which chips and other electronic components are placed)	De-soldering and removal of computer chips; open burning and acid baths to remove final metals after chips are removed	Air emissions as well as discharge into rivers of glass, dust, tin, lead, brominated dioxin, beryllium cadmium and mercury
Chips and other gold-plated components	Chemical stripping using nitric and hydrochloric acid and burning of chips	Hydrocarbons, heavy metals, brominated substances discharged directly into rivers, acidifying fish and flora. Tin and lead contamination of surface and groundwater; air emissions of brominated dioxins, heavy metals and hydrocarbons
Plastics from printers, keyboards, monitors, etc.	Shredding and low temp melting to be reused	Emissions of brominated dioxins, heavy metals and hydrocarbons
Computer wires	Open burning and stripping to remove copper	Hydrocarbon ashes released into air, water and soil

2.4 Heavy metals in different E-waste appliances

Usually different appliances has different components of heavy metals, Table 2.3 presents the different heavy metals and their sources in terms of E. waste , as it was summarized by Frazzoli (2010) and supported by Zheng et al, (2013) who also classified the different appliances and their heavy metals contained.

Table (2.3): Heavy metals that may be present in e-waste (Frazzoli, 2010)

Metals	Relationship with e-waste
Antimony (Sb)	Semiconductors (SbH ₃), flame retarded plastic (Sb ₂ O ₃), solders, CRT-glass, Pb-acid batteries
Arsenic (As)	As GaAs in MMICs, LEDs, laser diodes and solar cells
Asbestos	In some old items that must resist heat (coffee pots, heaters, etc.)
Barium (Ba)	Sparkplugs, fluorescent lamps, getter plates in vacuum tubes
Beryllium (Be)	Cu-Be alloy in springs, relays and solders. Power supply boxes and x-ray lenses
Cadmium (Cd)	Contacts, switches, solder joints, Ni-Cd batteries (CdO), stabilizers in PVC, CRT phosphors
Chromium (Cr[VI])	Coating on metal surfaces, steel alloys
Copper (Cu)	Wires, cables, PC-boards, relays, switches, electromagnetic motors, lead free solders
Lead (Pb)	Solders, CRT glass (PbO), stabilizers in PVC, lead-acid batteries

Mercury (Hg)	Hg-batteries, cold cathode lamps, switches, relays, thermostats, sensors, medical equipment, telecom equipment.
Nickel (Ni)	Ni-Cd batteries, electron guns of CRTs
Selenium (Se)	Photocopying machines, photocells, light meters, solar cells, rectifiers and x-ray cameras
Silver (Ag)	Wiring switches
Zinc (Zn)	ZnS in luminescent pigments of CRTs

2.5 Effects of E-waste constituents on health

The main risks to human health arise from the presence of heavy metals in E-waste, flame retardants and other potentially hazardous substances. There are three main groups of substances that may be released during recycling and material recovery, which are of concern: original constituents of equipment, such as lead and mercury; substances that may be added during some recovery processes, such as cyanide, and substances that may be formed by recycling processes, such as dioxins. If improperly managed, such substances may pose significant risk on human and environment. As shown in table 2.4, the expected health effects of contamination with some heavy metals are listed below as summarized from many studies (Chen, et al.2012). Yu, et al.2006).

Table (2.4):Health Effects of E-waste constituents

Constituent	Health effects
Lead (PB)	Damage to central and peripheral nervous systems, blood systems and kidney damage and Affects brain development of children. It also affects Reproductive health growth , mental illness , and causes DNA damage
Cadmium (CD)	Toxic irreversible effects on human health ; Accumulates in kidney and liver, and neural damage
Mercury (Hg)	Chronic damage to the brain, Respiratory and skin disorders.Affects Reproductive health growth, mental illness, and also causes DNA damage
Hexavalent chromium (Cr) VI	Asthmatic bronchitis, DNA damage
Plastics including PVC	Burning produces dioxin that causes reproductive and developmental problems, Immune system damage and Interferes with regulatory hormones
Brominated flame retardants (BFR)	Disrupts endocrine system functions
Barium (Ba)	Short term exposure causes muscle weakness and damage to heart, liver and spleen
Beryllium (Be)	Carcinogenic (lung cancer), Inhalation of fumes and dust causes chronic beryllium disease or berylliosis, and Skin diseases such as warts
Chromium	Lungs dysfunction reproductive health and DNA

	damage
Copper	Headaches, dizziness, irritation in eye, nose, mouth, etc.

Chen,et al(2008) has investigated the health impacts from exposure to processing of imported electrical waste in China . The study performed tests on workers who worked in open air workshops in one town, the study also tested residents from this town, including children, and a control group of residents and children from another town who were also recruited for this study. The study found differences in blood biochemistry, and measure of immune system functioning between workers and residents of town , and differences between tests of workshops workers as compared to residents of the control town.

2.6Pollution with lead in particular

2.6.1 Introduction about lead

Lead is the commonest of the heavy elements, accounting for 13 mg/kg of the earth's crust. Several stable isotopes of lead exist in nature, including, in order of abundance, ^{208}Pb , ^{206}Pb , ^{207}Pb , and ^{204}Pb (WHO, 2003) . Lead is a relatively corrosion-resistant, dense, ductile, and malleable metal that has been used by humans for at least 5,000 years. During this time, lead production has increased from an estimated 10 tons per year to 1,000,000 tons per year, due population and economic growth (Davidson and Rabinowitz 1992).Lead is used mainly in the production of lead-acid batteries, plumbing materials and alloys. Other uses are in cable sheathing, paints, glazes and ammunition. Human occupational exposure can also take place during the application and

removal of protective lead-containing paints, during the grinding, welding and cutting of materials painted with lead-containing paints, such as in shipbuilding, construction, demolition industries, and fabrication of heavy lead glass and crystal, and in crystal carving. Mining, smelting, and informal processing and recycling of electric and electronic waste can also be significant sources of exposure(Fewtrell,et al. 2003).

2.6.2 Source of lead in environment

Lead can be ingested from various sources, including lead paint and house dust contaminated by lead paint, as well as soil, drinking water, and food (Brown,et al. 2012). Lead has been also used as antiknock and lubricating agents in petrol, although the majority of lead is emitted from vehicles in the form of inorganic particles. This use has been phased out in most countries, which has resulted in a significant reduction of human exposure and mean blood lead levels. In the few parts of the world where leaded petrol is still in use, however, it continues to be a major source of exposure. Old industrial hotspots that have not been cleaned up can also represent a hazard even years after contamination has stopped, particularly to children who might ingest contaminated soil or dust as a result of their hand-to-mouth behavior(IPCS 1995).

(Liang,et al. 2018) concluded that the main source of lead contamination for children in shanghai was from Coal-Fired Ash after Phasing out of lead rather than vehicle exhaust, dust, and drinking water. More than 80% of the daily intake of lead is derived from the ingestion of food, dirt, and dust. The average daily intake of lead from water forms a relatively small concentration (5 µg/liter) of the total daily intake for children and adults, but a significant one for bottle-fed infants.(WHO 2003)

2.6.3 Sources of exposure to lead

According WHO (2010) Lead is found at low levels in Earth's crust, mainly as lead sulfide. However, the widespread occurrence of lead in the environment is largely the result of human activity, such as mining, smelting, refining and informal recycling of lead; use of leaded petrol (gasoline); production of lead-acid batteries and paints; jewellery making, soldering, ceramics and leaded glass manufacture in informal and cottage (home-based) industries; electronic waste; and use in water pipes and solder. Contaminated dust may be the main source of exposure for infants in countries that no longer use leaded petrol. The weathering, peeling or chipping of lead-based paints, mainly found in older houses, plays a role in children's exposure, especially as some young children eat the fragments or lick dust-laden fingers. Lead-containing dust may be brought into the home on the clothes of those who work in industries where such dust is generated. Some toys either are made from lead or contain lead (e.g. some plastics or paints)(WHO 2007)

Lead present in tap water is rarely the result of its dissolution from natural sources but is mainly due to household plumbing systems containing lead pipes, solders and fittings. Water that has been in contact with lead in this way for an extended period (e.g. overnight) will have a higher concentration. Thus, lead concentrations can vary over the day, and flushing of the taps before use is a control mechanism. Soft acidic water dissolves the most lead(WHO 2003).

Polyvinyl chloride(PVC) pipes also contain lead compounds that can be leached from them and result in high lead concentrations in drinking-water. The amount of lead dissolved from the plumbing system depends on several factors, including the presence of chloride and dissolved

oxygen, pH, temperature, water softness, and standing time of the water, soft, acidic water being the most plumbosolvent (Schock1989). Although lead can be leached from lead piping indefinitely, it appears that the leaching of lead from soldered joints and brass taps decreases with time (Levin,etal.1989). The greater the concentration of lead in drinking water and the greater amount of lead-contaminated drinking water consumed, the greater the exposure to lead(Lanphear,et al.1998)

(Triantafyllidon, and Edwards2011), points out that the major cause of lead contamination on tap water in the United State is lead exposure which is relative to contribute of lead in water to lead in blood.

(Zietz,et al.2007) concluded that there were regional differences in the frequency of tap water contamination in Germany ,which is the Multi-family houses were more frequently affected than single- and double-family houses , where 6.49% had lead concentrations exceeding 10 µg/l (recommended limit of the World Health Organization) and 2.79% had concentrations above the limit of the German drinking water ordinance (25 µg/l).

2.6.4 lead in water

Lead is unlikely to be present in source water unless a specific source of contamination exists. However, lead has long been used in the plumbing materials and solder that are in contact with drinking water as it is transported from its source into homes. Lead leaches into tap water through the corrosion of plumbing materials that contain lead (Levin. 1989).

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containing lead pipes, solders and fittings. Water that has been in contact with lead in this way for an extended period (e.g. overnight) will have a higher concentration. Thus, lead concentrations can vary over the day, and flushing of the taps before use is a control mechanism. Soft acidic water dissolves the most lead(WHO 2003).

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The WHO's guide line value(WHO, 2004)for lead in drinking water is 10mg/l based on a tolerable weekly lead intake of 25mg/kg body weight with 50% of this intake allocated to drinking water. The concentrations of lead in water was found in the literature 5 micrograms/l (Fewtrell,et al.2003) in a study conducted in the Hamburg, Germany. In another study in southern Saxonia conducted by (Englert,et al.1994)found that the

median concentration of lead in water were 8.3 micrograms/dl and of lead in tap water 24 and 2600 mg/l.

2.7 Similar studies Normal values of lead in water , blood and air

Lead is a pervasive environmental contaminant. The adverse health effects of lead exposure in children and adults are well documented, and no safe blood lead threshold in children has been identified. Because lead accumulates in the body, all sources of lead should be controlled or eliminated to prevent childhood lead poisoning (Brow,et al.2012). It has been estimated that lead exposure was responsible, in 2004, for 143 000 deaths and 0.6% of the global burden of disease (expressed in disability-adjusted life years, or DALYs),taking into account mild mental retardation and cardiovascular outcomes resulting from exposure to lead(WHO 2009).According WHO (2004) Lead in the body is distributed to the brain, liver, kidney and bones. It is stored in the teeth and bones, where it accumulates over time. Human exposure can be accessed directly through measurement of lead in blood, teeth or bones (bone and tooth lead reflect cumulative exposure).

2.8 Effects of lead exposure on children and pregnant women

In children it seems that many variables affect the extent of exposure. Because lead accumulates in the body, all sources of lead should be controlled or eliminated to prevent childhood lead poisoning (Brown,et al.2012).The concentration of lead, total amount of lead consumed, and duration of lead exposure influence the severity of health effects (Brown,et al.2012). According to (Sepúlveda,et al. 2010).in relation to

Lead poisoning , infants, children up to 6 years of age, fetus, and pregnant women are the most susceptible to adverse health effects.

(Zheng, et al. 2013) concluded the relevant factors of the environmental pollution especially ,lead pollution that affects Blood lead and cadmium levels in children, are threatening the health of children living around e-waste recycling site.

The potential for adverse effects of lead exposure is greater for children than for adults, because in children:

The intake of lead per unit body weight is higher, more dust may be ingested, lead absorption in the gastrointestinal tract is higher, the blood– brain barrier is not yet fully developed , and neurological effects occur at lower levels than in adults. (WHO 2007)

The most critical effect of lead in young children is that on the developing nervous system. Subtle effects on intelligence quotient (IQ) are expected from blood lead levels at least as low as 5 µg/dl, and the effects gradually increase with increasing levels of lead in blood. In a 2010 review of the latest scientific evidence indicating effects at lower levels of lead , did not provide any indication of a threshold for the key adverse effects of lead(WHO 2010). Lead exposure has also been linked epidemiologically to attention deficit disorder and aggression (International Agency for Research on Cancer 2006).

(Lanphear,et al.2000) concluded in their study investigating the effect of blood lead exposure on cognitive abilities of children , that , the cognitive and academic skills associated with lead exposure occur at

blood lead concentrations lower than 5 mg/dL(50 PPb) in US children and adolescents. Also in Europe the effect of blood lead was investigated.

From the studies Liu and Xu (2008) it seems that the blood lead level affects temperament, physical activity and approach of withdrawal, they studied the association between lead exposure from electronic waste recycling and child temperament alterations, and evaluated the dose-dependent effects of lead exposure on temperament alterations in children from a primitive e-waste recycling area in Guiyu of China and a control area (Chendian, China). They correlated the Blood lead levels (BLL) with temperament, health, physical examination, and residential questionnaires. They collected blood samples from 303 children (aged 3-7 years old) between January and February 2008. Child BLL were higher in Guiyu than in Chendian (median 13.2 $\mu\text{g/dL}$, range 4.0-48.5 $\mu\text{g/dL}$ vs. 8.2 $\mu\text{g/dL}$, 0-21.3 $\mu\text{g/dL}$) ($P < 0.01$). Significant differences of mean scores in activity level, withdrawal, and adaptability were found between Guiyu and Chendian children (all $P < 0.01$). High BLL ($\text{BLL} \geq 10 \mu\text{g/dL}$) child had higher mean scores of approach-withdrawal when compared with those children with low BLL ($\text{BLL} < 10 \mu\text{g/dL}$) ($P < 0.01$).

In terms of effect on pregnant women, The presence of lead in drinking water poses a range of risks to human health, including the retardation of some aspects of child development, the inducement of abortion, and other clinical disorders. (Hayes and Skubala. 2009). According to the International Program on Chemical Safety (1995). Exposure of pregnant women to high levels of lead can cause miscarriage, stillbirth, premature birth and low birth weight, as well as minor malformations. these recommendations were supported by (vector, et al. 1999) and

(Hertz2000)whom they concluded that evaluation of low to moderate level lead exposures have reported mixed findings regarding the risk of spontaneous abortion of pregnant women in Mexico City that conclude the Low to moderate lead exposures may increase the risk for spontaneous abortion at exposures comparable to US general population levels.

2.9 Effects of lead exposure on Adults

Adults with occupational exposure to lead were reported to have less immunity, as they were registered to have more colds and influenza and exhibit suppressed secretory immunoglobulin A (IgA) levels, demonstrating lead-induced suppression of humeral immunity (Klaassen,et al. 2008).

Adults with occupational exposure also might have neurotoxin effects, including peripheral neuropathy. Motor nerve dysfunction can occur at Blood Lead Levels as low as 40 $\mu\text{g}/\text{dL}$ (Goyer. 1990).Lead also is nephrotoxic and can cause progressive nephron loss leading to renal failure, gout, and hypertension. In a meta-analysis of the relationship between Blood Lead Level (BLL) and blood pressure, a small but statistically significant association between increased BLL and increased blood pressure was identified (Nawrot,et al. 2002). BLLs $\geq 40 \mu\text{g}/\text{dL}$ have been associated with increased risk for cardiovascular, cancer, and all-cause mortality in several epidemiological studies.

(Anttila, et al.1995) found that the examination of the workers who works in workshops that are contamination with exposure to lead in Finland, has an increased risk of lung cancer. Those results were also

supported by Boffetta1995) , who found that the workers with heavy exposure to lead , have more increase of risk of stomach and lung cancer . To some extent, the risk of lung cancer might be explained by confounders such as tobacco smoking and exposure to other occupational carcinogens.

(Mark and Silbergeld 2002) pointed out that occupationally exposed workers who have blood lead levels of 20 to 29 $\mu\text{g/dL}$ have significantly increased risk of circulatory, and cardiovascular mortality from 1976 through 1992.

There is some evidence that long-term occupational exposure to lead (chronic exposure) may contribute to the development of cancer(The International Agency for Research on Cancer. 2006). According WHO 2010 Chronic lead exposure commonly causes hematological effects, such as anemia, or neurological disturbances, including headache, irritability, lethargy, convulsions, muscle weakness, ataxia, tremors and paralysis , may appear in adults at blood lead levels of 50–80 $\mu\text{g/dl}$. (WHO 2010).

Renal disease has long been associated with lead poisoning; however, chronic nephropathy in adults and children has not been detected below blood lead levels of 40 $\mu\text{g/dl}$ (Campbell,et al. and Lilis,et al. 1977). Staessen ,et al.1992) stressed that increasing the blood lead concentration in the general population due to exposure to lead that may impair renal function.Damage to the kidneys includes acute proximal tubular dysfunction and is characterized by the appearance of prominent inclusion bodies of a lead–protein complex in the proximal tubular

epithelial cells at blood lead concentrations of 40–80 µg/dl (Ritz,etal.1988).

(Jeffrey,etal.2010) talked about the blood lead level and kidney function among adolescents in US , when there is high chronic exposure to lead, it increases the accumulative lead in blood, which in turn causes chronic kidney dysfunction (CKD) in adults and children. (paul,etal.2005) emphasized that the Higher blood lead levels remain associated with a higher burden of chronic kidney and peripheral arterial diseases among the overall population.

2.10 blood lead level and Hemoglobin .

The concentrations of lead in blood found in the literature ranged between 1.5-24 mg/m³ (Masci,et al. 1998), in the study conducted in the USA. However the study in Nigeria conducted by Bello et al. (2016) found that the median concentration of lead in blood levels in children and adults were 2.1 and 1.3 µg/dL, 3.1 and 1.8 µg/dL, (which equals 21 and 13 ppb, and 31 and 18 ppb respectively).(chen,et al.2012) found that the result of Environmental Lead Pollution, Blood Lead concentration in the males aged under 31, from 31 - 45 and from 46 - 60 were 98.55, 100.23, and 101.45 µg/L respectively) , which is equal to (98, 100, and 101 ppb respectively)

(Kutllovci, et al.2014) conducted a case control study that investigated lead concentration in both exposed and none exposed communities in Serbia , and studied the correlation between blood lead level and hemoglobin level . The average value of blood lead level of Mitrovica pupils (exposed) was 2.4 µg/dL (SD±1.9µg/dL), range 0.5 to 16.3µg/dL. The average value of blood lead level of Shtime pupils was 2.3µg/dL

(SD \pm 0.7 μ g/dL), range 1.2 to 5.2 μ g/dL with no statistical significant difference of exposed and non-exposed in the kindergarten age category. However when he compared the pupils concentration with kindergarten concentration at the exposed area itself, he found that the average value of blood lead level in kindergarten children of Mitrovica was 3.8 μ g/dL (SD \pm 1.3 μ g/dL), range 2.2 to 7.7 μ g/dL with significant difference between the average values of blood lead levels of pupils and kindergarten children of Mitrovica ($P < 0.0001$). with kindergarten being more affected from lead poisoning.

The average value of hemoglobin in the pupils of Mitrovica was 14.0g/dL (SD \pm 3.7g/dL), range 9.4 to 25.6 g/dL. The average value of hemoglobin to pupils of Shtime (control) was 11.4g/dl (SD \pm 0.8 g/dl), range 9.2 to 13.0 g/dl with significant difference between mean values of hemoglobin in pupils of Mitrovica and Shtime ($U = 6440.0$, $P < 0.0001$). With Spearman correlation is found significant correlation of a medium scale ($r = -0.305$, $df = 248$, $p < 0.0001$) between blood lead levels and hemoglobin level in the blood.

(Hu, et al. 1994) found that the patella concentration of lead with adjustment to age, smoking, BMI, was correlated with decreased hemoglobin concentration. (Charache and weatherall 1996) investigated Fast Hemoglobin in Lead Poisoning in blood and found a correlation of anemia and blood lead poisoning. Tripathi et al (2001) studied the Blood lead and its effect on hemoglobin levels of children and found a negative significant relationship ($r = 0.61$) between blood concentration of lead and Hemoglobin in the children of Mumbai and HaiderAbad. (Grandjean et al. 1989) studied the blood lead-blood pressure relations, alcohol intake

and hemoglobin as confounders, and found that the blood lead together with alcohol intake were significantly associated with hemoglobin level.

Chapter 3: Research Methodology

3.1 Introduction

In this chapter the researcher presents of the main study methodology and plan, that includes the sample and sampling techniques, design, tools and procedure of data collection, and the statistical analysis. Ethical considerations will be also presented in this chapter.

3.2 Research settings

This study was conducted on target area of Beit Awwa village. Total population of Beit Awwa village is 10,649. Non-xposed area is Halhul with a total population 29,222. (Palestinian central bureau of statistics, 2016)

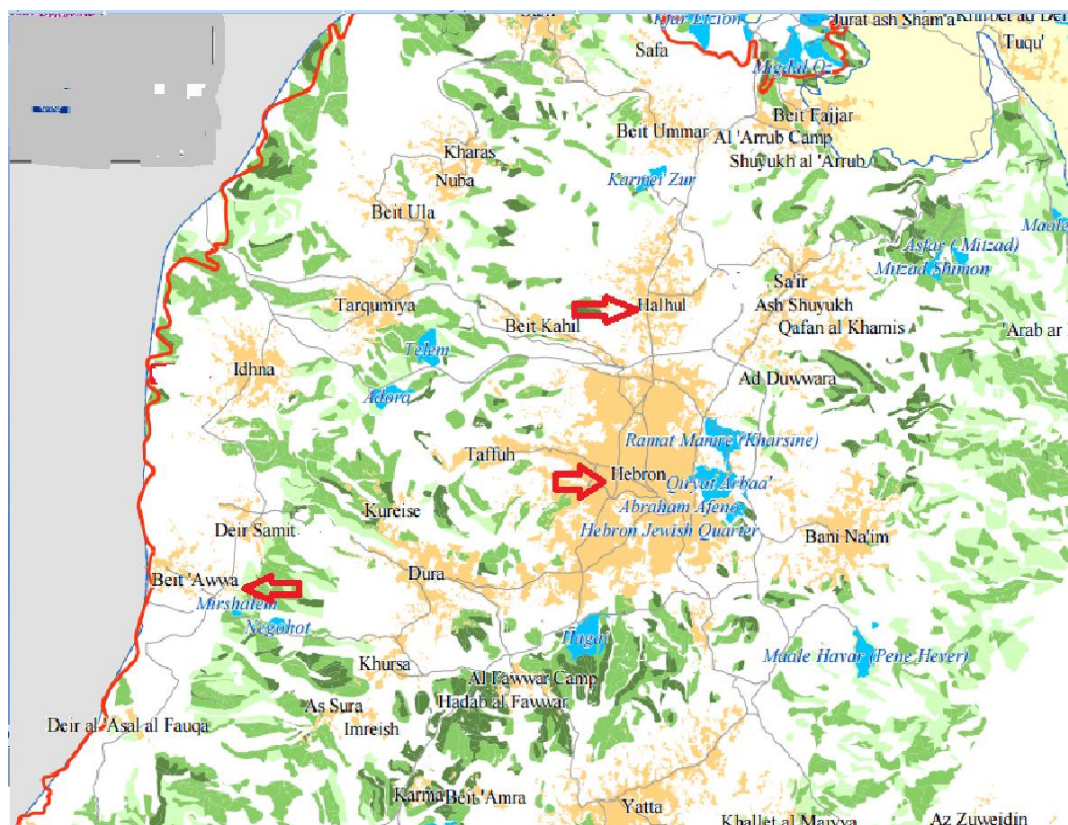


Figure (3.1): Map shows target Area (Beit Awwa) and non-exposed Area (Halhul)

3.3 sampling and population

3.3.1 Sample size

Based on the results of means and SD of exposed and none exposed in the study of Kutllovci et al (2014) , we used the Medclac software to calculate the expected proper sample size (Figure 3.2)and we used the following input for the software difference of mean (1.4) SD in group 1 (1.9) and the SD in group 2 0.7 and the ratio sample size as 1/1 with type II Error of .20 and type I error of 0.05. the calculated sample size for both exposed and then non-exposed was 36 samples.

At the same time the researcher had funding from green land society for health development in Hebron processing of a 100 sample. So we used this fund to have a bigger sample that would help in improving the power of the study.

Figure 3.2 sample size calculator Medclac

Sampling: comparison of means	
Type I and II error	
Type I error (Alpha, Significance):	0.05
Type II error (Beta, 1-Power):	0.20
Input	
Difference of means:	1.4
Standard deviation in group 1:	1.9
Standard deviation in group 2:	0.7
Ratio of sample sizes in Group 1 / Group 2:	1
Results	
Number of cases required in Group 1:	18
Number of cases required in Group 2:	18
Total sample size (both groups together):	36

3.3.2 Sampling methods

Simple random sampling method was used after dividing the areas into a distance that equals x/r , where x is the length of the main road and the r is the target value of sample size. That will allow us to take a sample that represents the village population from west to east. And if one potential participant refused to participate, the next house was taken.

3.3.3 Inclusion criteria

- **For the exposed in the affected area**
 - Population living in Beit Awwa
 - Age from 18-80 years
- **For the non-exposed area.**
 - Inhabitants of the non-exposed area Halhul
 - Age from 18 – 80 years

3.3.4 Exclusion criteria

The only exclusion criteria in all the current study will be as following.

- Age below 18 years and- Age over 80 years (for the current exposed and non-exposed)
- Population originally from the target area but not living there

3.4 Research methodology

3.4.1 Design

A descriptive Comparative design was used in this study.

The non-experimental causal-comparative quantitative method is defined as the researcher comparing two or more groups in terms of a cause (or independent variable) that has already happened (Creswell, 2014). The purpose of using this type of design is to generalize from a sample. It has advantages because of the quick in terms of time of data collection, the data are collected at one time, and is cost effective and convenient(Creswell, 2014).

The difference of this design from Case control study design , even though they look similar, that the case control studies concentrate of occurrence of outcome and diseases, while this type of studies is looking at exposure of risks, and its potential descriptive.

3.4.2 Tools of data collections

For the purpose of answering the questions of this research the researcher used different tools

1. Data capturing sheets

For Participants in the exposed and non-exposed groups, that included anthropometric data and data related to burning behavior, (appendix 2) health and medical history, also it had questions that indicates the populations perspective on the effect of burning on water quality and trends of prevalence of cancer, respiratory disease, miss-carriage, allergy, and other socioeconomic variables, in addition to information about the frequency and the intensity of burning of e-waste in their areas.

2. Blood tests.

To analyze the hemoglobin, and the concentration of lead in blood using ICP machine at Al-Quds university labs. The Agilent Technologies 7500 Series ICP- MS (Agilent 7500) can measure trace elements as low as one part per trillion (ppt) and quickly scan more than 70 elements to determine the composition of an unknown sample with Mass Hunter Workstation software that automates the analysis and accurately interprets the resulting data. The ICP/MS instrument consists of an on-board peristaltic pump that controls the flow of sample solution into, and waste (drain) out of the instrument, a nebulizer (Micro Mist nebulizer) that uses a stream of argon to disperse the sample, an ICP Argon plasma torch using Argon as plasma gas, auxiliary gas and nebulizer (carrier) gas, two pumps for evacuation, Quadrupole mass analyzer with unit resolution, an octapole reaction system (ORS), and electron multiplier detector.

The operating conditions are as follows: nebulizer gas (argon) flow rate: 0.9 L/min, auxiliary gas (argon) flow 0.3 L/min, plasma (Argon) gas

flow: 15 L/min, reaction gas flow (helium) 4mL/min, lens voltage 7.25 V, ICP RF power: 1100 W.

3.4.3. Procedure of data collection

After permissions(**Board green land committee permission**)were granted, the multi aphasic health research started as following.

- Formation staff, consist of :Nurses, a laboratory technician and researchers relevant to the study
- Building up of the research data capturing sheet
- Contact with local authorities in the Beit Awwa village.
 - Allocation of the participants from the exposed and non-exposed area took place.
 - Explanation about the research was given and consent for was signed
 - Data capturing sheet was filled from the participants before asking the sample
 - Then blood samples were withdrawn, and serum was separated and sent to Al-Quds University labs for analysis of heavy metal concentration. Also Hb was analyzed at the spot of collection using portable CBC device.
 - Water samples was collected from all water springs in the exposed area, and compared to the non-exposed springs. Then sent for analysis for heavy metals concentration at Al-Quds University Labs.
 - Water sample from domestic sources were collected from house tape water.
 - Samples were kept in ice and sent to Al-Quds University lab.
 - All data was collected from 15 September 2015 to 1 April 2016

3.4.4 Statistical analysis

Data collected were entered to the SPSS program using version NO 20, then descriptive statistics was used to show the mean concentration of heavy metals in exposed and non-exposed. Shapiro wilk test was used to test the normality of data, to decide on parametric and none parametric tests for analysis. Independent sample T test was used to highlight the difference of mean concentration in exposed and non-exposed, so that for the hemoglobin level, and concentration of heavy metals in both exposed and none exposed areas. Where data was not normal, Mann Whitney none parametric test was used.

Correlation spearman r was used to investigate the correlation between continues (none normal) variables and level of heavy metal from one side, and the level of Hemoglobin on the other side.

3.5 Ethical considerations

The participants were requested to sign a consent form (Appendix 1) , codes will be used in analysis, and re assuring that the results will be used for scientific reasons only , all participants will have an open access to the results of the research.

3.6 Limitations of the study

- Lack of other professionals in the team of the research
- The difficulty of communicating with the participants in the study
- Non-participation of children in the study
- Lack of knowledge of the enough topography of the area

Chapter Four:

Results

4.1 Results

4.1.1 population point of views on e-waste burning

In this sub section the researcher presents below some of the results of the questionnaire distributed on people living in the exposed area , about their views of the effect of e-waste burning on water from their own point of view

4.1.1.1 Burning and house hold water

Residents expressed concern about the effects of e-waste burning on water resources, especially springs, agricultural and domestic wells, and particularly in the areas near e-waste disposal practices and burning. A minority of the population (39%) agreed or strongly agree that e-waste has a direct effect on their household water, for which the municipality is responsible.

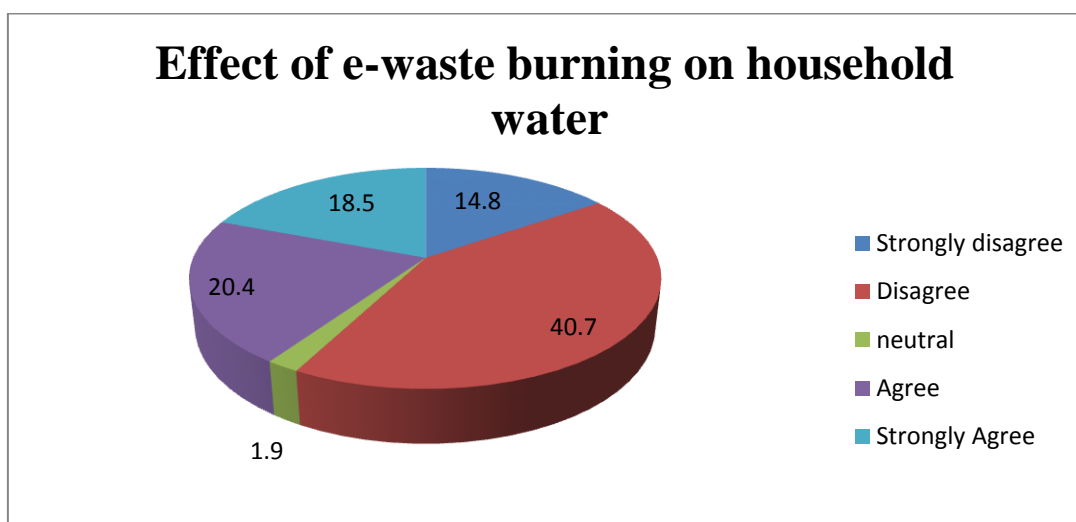


Figure 4.1: Population points of view on effects of e-waste burning on household water

4.1.1 .2 Burning and natural water natural resources

The following figure shows population points of view on the effects of Electronic-waste burning on domestic water wells; 55% of the population agreed that e-waste burning affects the natural water resources.

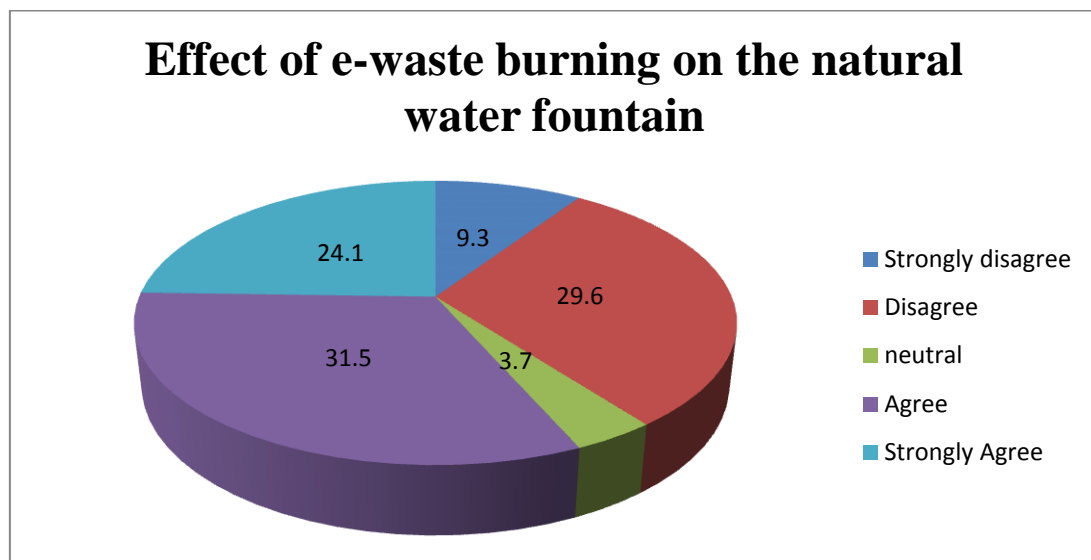


Figure 4.2Population points of view on effect of Electronic-waste burning on the natural water fountain

The majority of the population (69%) disagreed that Electronic-waste burning has an effect on water taste, as shown in the following figure.

4.1.1 .3 The effect of e-waste burning on water smell and taste

As shown in figure 4.3 and figure 4.4, that the majority of participants don't agree with the statement indicating that the e-waste burning changed the smell or taste of water.

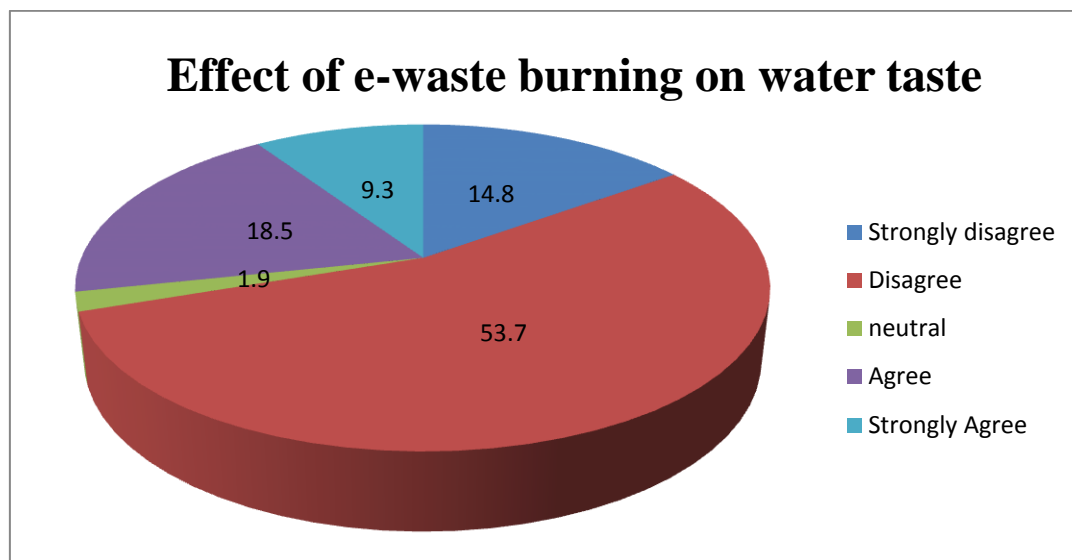


Figure 4.3: Population point of view on effect of e-waste burning on water taste

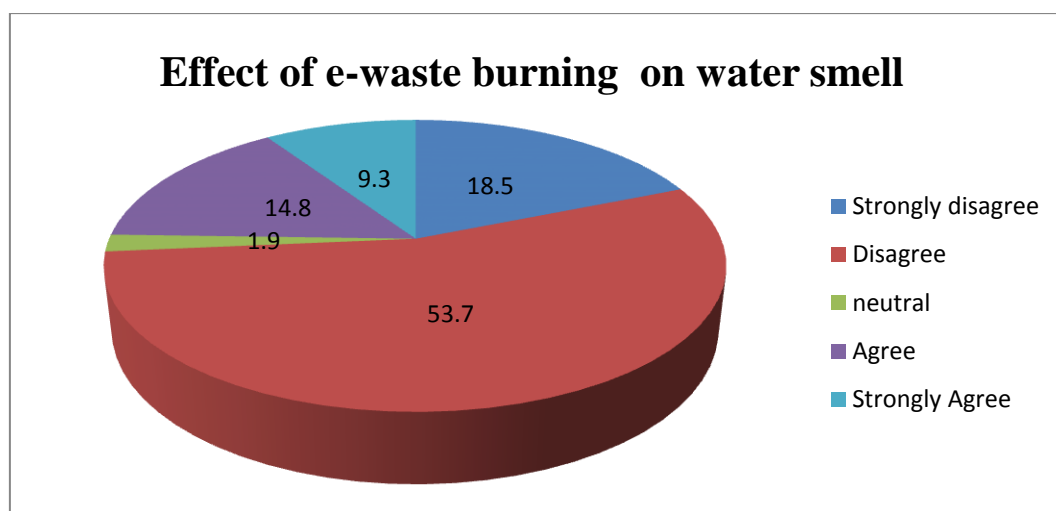


Figure 4.4: Population points of view on effect of e-waste burning on water smell

4.1.2 Lead concentrations in water springs .

As shown in Table 4.1 the mean and standard deviation for the water springs sample, shows that there is a statistically significant increase of Pb concentration in spring's water from the exposed area as compared to the non-exposed springs of water ($p < 0.05$)

Table (4.1): Descriptive statistics and P value for lead concentrations in water springs.

Element	Status	Mean	SD	Median	Std. Error Mean	t	P
Pb	springs exposed	3.30	6.80	36.00	1.56	5.14	0.00
	springs non-exposed	2.74	5.08	21.5	1.60		

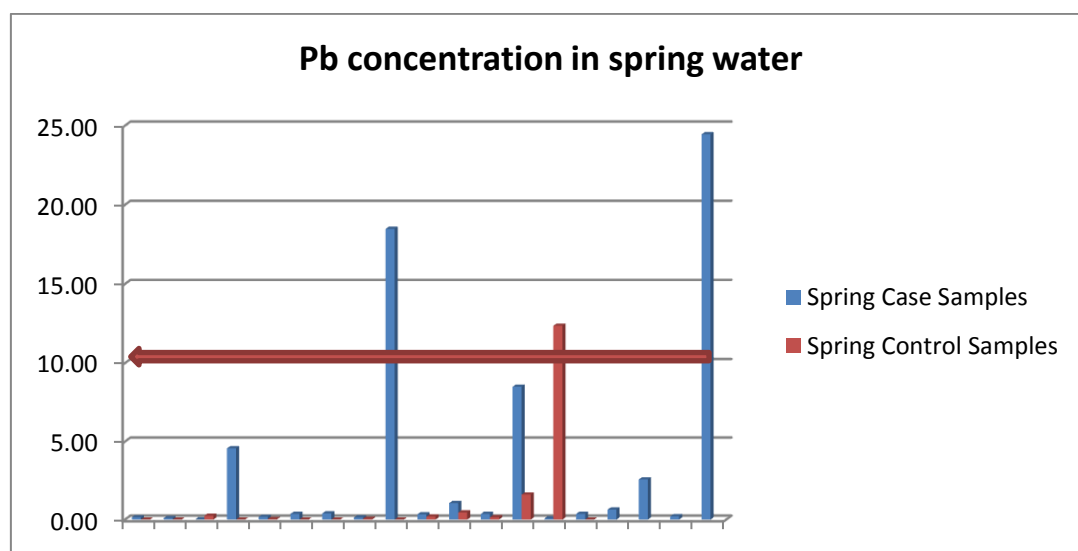


Figure (4.5) Variation of lead concentrations in spring exposed and non-exposed samples

According to the independent sample t test ($P < 0.05$) the Pb concentration in springs of water is more in exposed than in non-exposed.

4.1.3 Lead concentrations in domestic water.

As shown in Table 4.2 below, the difference in Pb concentration in both exposed and non-exposed areas, in terms of domestic drinking water is nearly similar.

Table (4.2): Descriptive statistics and P value for lead concentrations in domestic water samples (exposed and non-exposed)

Element	Status	Mean	Std. Deviation	Std. Error Mean	U	P value
Pb	Domestic water non-exposed	2.1	1.7	0.3	0.504	0.523
	Domestic water exposed	1.7	3.5	0.6		

According to the Mann Whitney none parametric test ($P = 0.523 : > 0.05$) the lead concentration in water does not statistically differ significantly between exposed and non-exposed

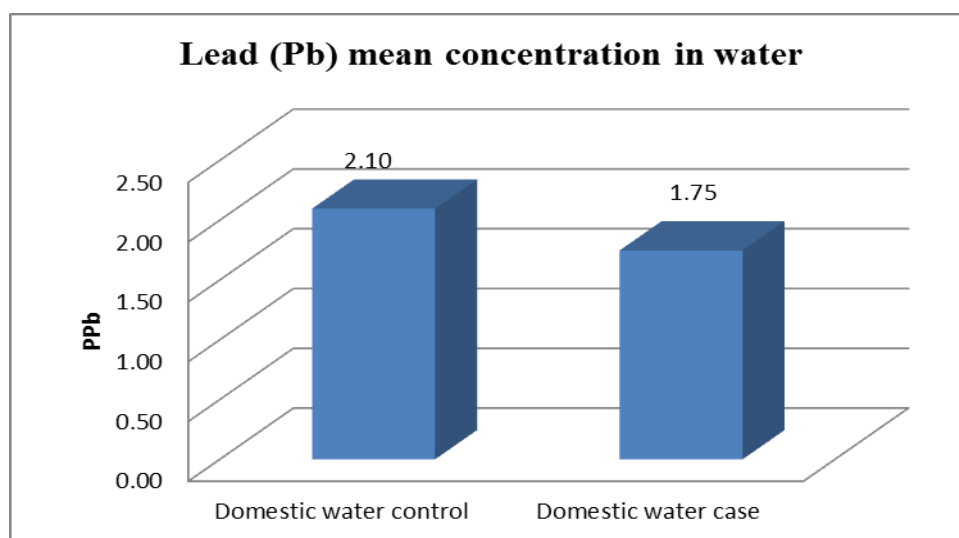


Figure (4.6) Variation of lead mean concentrations in domestic exposed and non-exposed samples

4.1.4 Lead concentration in Blood .

The following table (4.3) shows the statistical analysis of the concentration of lead in blood. Using Shapiro wilk test we found that the data of Pb concentration was not normal $p < 0.05$. so none parametric Mann Whitney test was used to test the significance of difference between exposed and non-exposed in terms of Pb concentration in Blood , as shown in table 4.3 and table 4.4 that there is a statistical significant difference between concentration of Pb in exposed and concentration in non-exposed with more lead concentration in exposed than In non-exposed.

Table (4.3) descriptive statistics of Pb concentration in blood in exposed and non-exposed

	status	N	Mean Rank	Median	Sum of Ranks
Pb.conc	Non-exposed	50	49.87	28.3	2493.50
	exposed	54	54.94	33.7	2966.50
	Total	104			

Table(4.4)Mann Whitney test (exposed and non-exposed)

	Pb.conc
Mann-Whitney U	1218.500
Wilcoxon W	2493.500
Z	-.856-
Asymp. Sig. (2-tailed)	.0392
a. Grouping Variable: status.c	

As shown in figure 4.7, the exposed is higher than non-exposed by a total of 5%. $P < 0.05$

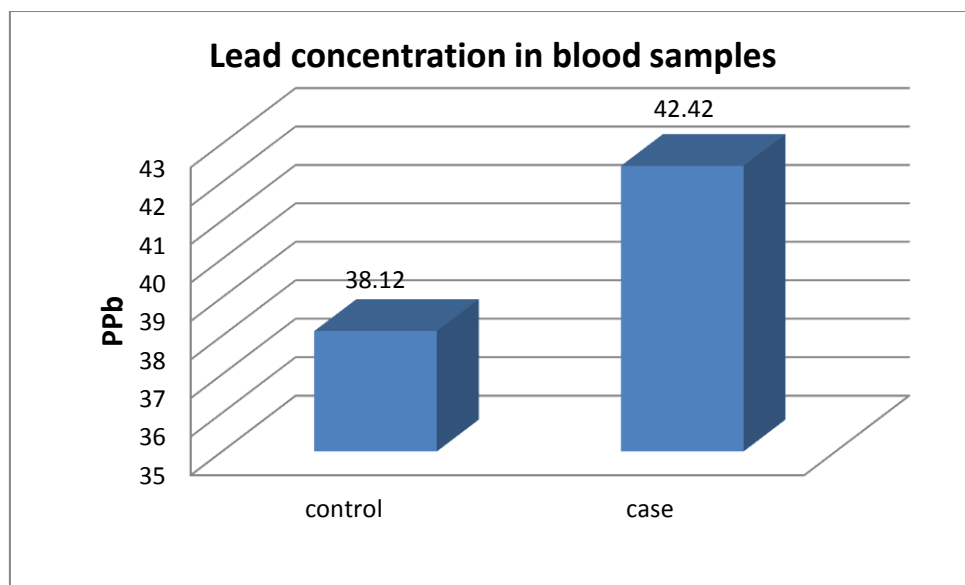


Figure (4.7) Variation of lead concentrations in exposed and non-exposed samples

4.1.4.1 Comparison of blood level lead to WHO standers

Testing the normality by Shapiro Wilk test, shows that the data when the exposed sample are tested alone is normally distributed, so we applied one sample T test to investigate the significance of difference of current concentration of lead in blood wit WHO standards of (20 ppb) , that the current concentrations are significantly higher than WHO standers $p < 0.05$.

One-Sample Test

	Test Value = 20					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Pb.conc	4.140	53	.000	22.42111	11.5586	33.2836

4.1.4.2 Lead in blood workers

The following table shows high concentrations of lead in workers samples compared to population. independent sample T test was use to check the significance of difference of lead concentration between workers and population , and as shown in Table 4.5 and Figure 4.9 that there is a 17% more concentration of lead in blood sample of exposed as compared to non-exposed $p < 0.05$

Table (4.5) Descriptive statistics of lead concentration in workers' blood samples

nature		N	Mean	Std. Deviation	Std. Error Mean
Pb.conc	population	44	39.5	21.99215	3.31544
	workers	10	55.0	82.46094	26.07644

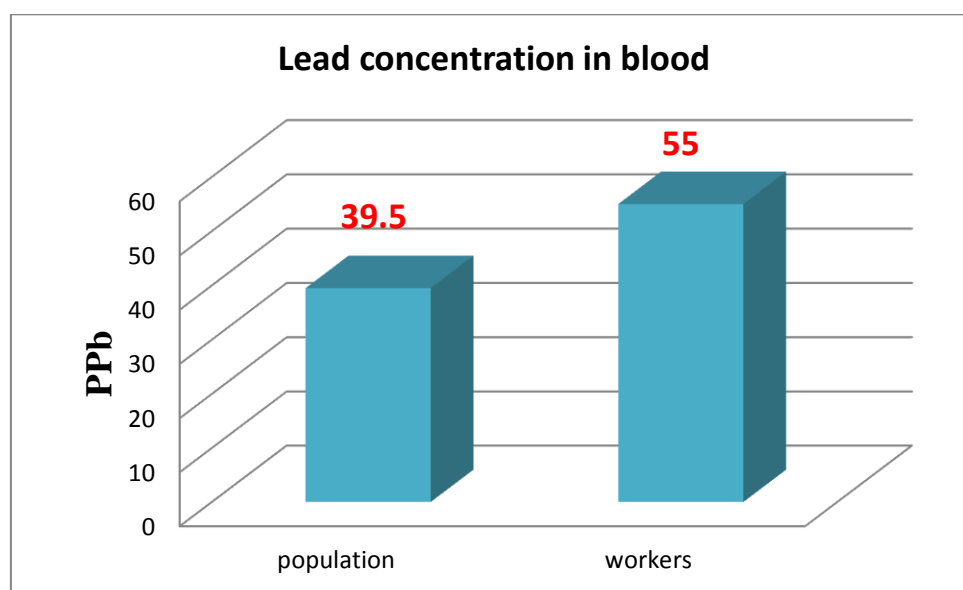


Figure (4.8) Lead concentrations in blood of population and workers

Table (4.6)Independent Samples Test for workers VS population Lead concentration

	Levene's Test for Equality of Variance s		t-test for Equality of Means						
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
Pb.conc	9.633	.003	-1.111	52	.272	-15.45491	13.91117	-43.36971	12.45989
Equal variances assumed									
Equal variances not assumed			-.588	9.293	.04571	-15.45491	26.28636	-74.63439	43.72457

4.1.4.3 Factors correlated with high lead

As shown in table 4.7 that there was a statistically significant correlation between the lead concentration in blood and the monthly frequency of burning and the distance between home and the closest burning site ($p < 0.05$)

Table (4.7) factors correlated with higher lead concentration n

Monthly frequency	Correlation Coefficient	.543*
	Sig. (2-tailed)	.016
Distance from burning site	Correlation Coefficient	-.423*
	Sig. (2-tailed)	0.035

4.1.4.4 Differences in lead upon categorical variables

There were no gender differences in terms of Pb concentration I blood or any other factors like the direction where the participants lived in the village in terms of west , east, north, south ($p < 0.05$)

4.1.5. Hemoglobin level and lead

Analysis of the relationship between hemoglobin in exposed and in non-exposed according to t-test shows in table 4.8 and figure 4.10 that there are is a higher hemoglobin value in the exposed as compared to the non-exposed , $p < 0.05$.

Table (4.8) Descriptive statistics, significance and t test for hemoglobin exposed and non-exposed

	status	Mean	Sig	T
Hemoglobin Blood test	exposed	11.2833	0.018	-1.78
	Non-exposed	12.1900		

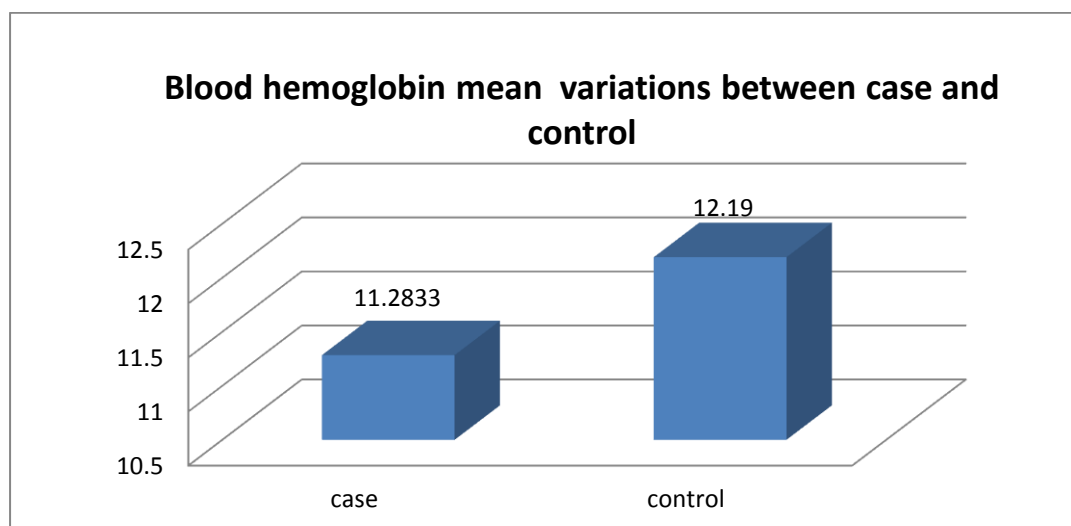


Figure (4.9) Blood hemoglobin variations between exposed and non-exposed

4.1.5.1 Variables correlated with Hemoglobin in blood

Variables that were correlated with lower hemoglobin as shown in table 4.9 were concentration of Pb in blood and the distance between home and the closest burning site

Table (4.9) factors correlated with less hemoglobin in blood

Distance burn with hemoglobin	Correlation Coefficient	.075	.349*
	Sig. (2-tailed)	.610	.014
Pb. Conc. with hemoglobin concentration	Correlation Coefficient	1.000	-.501
	Sig. (2-tailed)		.0145

4.6 Discussion of results:

as was presented in 4.1 that the inhabitants of Beit Awaai in the health survey mainly disagreed with the fact that the e waste burning affects their domestic household water quality, taste and smell. The reason behind that may be that Beit Awaai just as other villages in that area, are getting their water from pipes from the municipal authorities, which may justify why the people in that area were not mainly worried about their domestic household water. On the contrary of the domestic water, people do worry about the effect of burning on the water wells, as it collects water from the roofs which is in direct contact with smoke of burning, that may be eventually end up at the water wells, and contaminate it with the black smoke components of flame retardants and lead in particular.

There was a statistically Significant higher concentrations of lead >10PPb was found in springs of exposed as compared to the springs in the none exposed areas. and this probably due to the leachate that is as a result of e waste burning and practices, Further investigations should be done for leachate quality on all the springs in the area. There are hundreds of hazardous burning sites, that are informal, and changes the intensity of burning upon many variables. The problem with those sites, that when winter comes, the running water takes all the contaminated components of those burning sites, to ground water, which may have in turn appeared on the way of contaminated spring water quality by higher lead concentration. Further investigation should be performed as there are other factors that may affect the concentration of lead in springs water. The effect of this high concentration may be affecting the lead concentration in blood of people drinking from this water. As for the

sample itself from the exposed areas, the more close the spring was to burning sites, the more concentration of lead was found, which shows a negative relationship between distance from burning sites, and concentration of lead

According to the s tests performed in exposed and non-exposed areas , it appeared that there is not statistically significant difference in terms of domestic water concentration of lead, and this result is not surprising, as the domestic water source is mainly from municipality pipes that usually originate from Bethlehem area, which has nothing to do with exposure to the effect of burning , this is why it showed no relation to the actions of burning, further investigation of the difference between water wells dependent population and municipal pipes dependent uses, may be beneficial to detect any difference in lead contamination

There was a statistical significant difference of exposed areas lead concentration (42.42PPb.) as compared to none exposed (38.12 PPb.) , even though when we compare both exposed and none exposed concentration against the level 20 PPb(announced by WHO , 2015) we find that this score is high in both exposed and none exposed . our results of lead concentrating in blood compares much better than the concentration of blood lead levels in Serbia , china, Bangladesh, and India (Drita et al., 2014; Wang et al. 2012; Wasserman et al, 2007;) . and at the same time it is as a double as the blood lead concentration in USA (Jones, Homa, and Meyer, 2009).

The researcher assumes that the main reason behind this increase of blood lead concentration in exposed and none exposed may due to the fact of burning of e-waste practices in this area, which supports many

authors about the effect of burning on discharging toxic gases , specially lead (Cui and Forssberg, 2003; Niu and Li, 2007; and Pinto, 2008). At the same time the increased concentration in the none exposed areas, also indicates the presence of other environmental sources of pollution of lead in both the exposed and none exposed, may be due to that water pipes system for tap water as was reported by (WHO, 2003; and Schock . 1989) , and petrol use of lead in petrol as was indicated by IPCS (1995) , those two confounding factors that could not be controlled may be other contributing factors to this high concentration of lead in blood, and both represents an opportunity for further investigations and research to evaluate the extent of their effect on the current high levels of blood concentration of lead .

The implications of this high level of blood , that this should be worked against its further increase in order to prevent the possible consequences of high blood lead , as respiratory diseases, neural problems (Goyer. 1990) , cardiovascular complications (Nawrot, et al. 2002), immune system complications (Klaassen, et al. 2008) , and above all cancer (Anttila, et al., 1995)

Many solutions could be advised that would decrease the more emission of lead in the air, like the stripping of cables instead of burning the high content lead cables, covering those wires and cables, or the possibility of having modern incinerators for less burning and more environmentally friendly solutions of e-waste processing. And on top of that the possibility of selective importing of e-waste from the 1948 occupied territories where outlawing a list of high toxic material to prevent its entry to our Palestinian territories. In addition to that a public awareness campaign may help in decreasing the effect of burning on both population and

workers. All those solutions may become possible through formalization of this business as it has many indicators that it is less harmful and less polluting for the surrounding environment (Yu, and Wong, 2006).

The workers in this study showed to have more contamination of blood lead than did the control , this was referred to in many studies like in (Wong, 2007 ; Yu, and Wong, 2006). Which may be due to the fact those workers are in direct contact of handling , touching, and breathing fumes coming out from cutting, dismantling and burning of this e-waste, which may put the m in a position where they are more affected by the negative effects of exposure to lead through different routes, as their surrounding is much more toxic than the surroundings of the normal population, as it was indicated that the heaviest lead-contaminated zone in air after the burning of the e-waste is 75–100 cm above the ground as was pointed by (Wang,et al.2006).Which may explain this increase in blood lead concentration. More safe procedures of processing ma decrease this effect , as using gloves, masks, and using occupational health and safety codes of practice in their daily work, as it is in the formal level of the e-waste processing where those codes are strictly applied (Yu, and Wong, 2006).This results of increases toxicity in workers as compared to population residing the area of e-waste processing supports the findings of (Shen,et al.2004) who also had the same findings.

In terms of hemoglobin concentration , it was shown that the exposed areas had less hemoglobin (11.28) than in the none exposed area (12.19) , and in further analysis there was a statistical significant correlation between the Pb concentration and the hemoglobin level in blood , and distance from closest burring site, that thing that supports the findings of Kutllovci et al (2014) who did the study in Serbia, and at the same time

our hemoglobin results were around 2.5 unites less than his study. And at the same time those results supports the results of (Hu,etal.1994) who concluded that there is a negative correlation between blood hemoglobin level and the patella lead concentration. Despite the fact that anemia in general may have many other nutritional and health related other reasons, it is a major findings that should be traced and followed up in further future investigations to decrease the negative effect of Anemia on children specially that they were not included in this study and that should be part of further studies in the future.

Chapter Five: Conclusions and Recommendations

5.1. Conclusions:

In this descriptive comparative study there were differences in lead concentration as compared to non-exposed, in exposed areas to the process of e-waste processing and burning , the results for this study can be summarized by that the exposed areas had :

- Higher lead concentration in blood as compared none exposed
- Workers in the field of the e-waste processing and burning had a higher blood lead concentration when compared to normal population.
- Higher concentration of lead in springs of water as compared to lead in the springs of water in the non- exposed
- Less blood hemoglobin as compared to hemoglobin in the none exposed area .
- The less Hemoglobin was associated with more Pb concentration and the closest distance to the first burning site form residence.
- Pb concentration itself was associated with the monthly frequency of burning and the distance from site of burning
- Testing the domestic water Pb concentration did not show any significant deference of concentration between the exposed and the none exposed areas

5.2 Recommendations:

Based on the finding , discussion and conclusion of this study the researcher recommends the following recommendations to be taken into considerations on the different levels of stock holders and works in the field, and the population

1. Formalization of this business sector, towards regulation of the processing of imported e-waste , and fulfilling all the occupational and safety measures on the processing itself and on workers
2. Emphasizing the importance of taking all measures to stop the burning of e-waste in this village , by all means of enforcement by law
3. Adopting the use of an environmentally and occupationally safe processing of this e-waste , that includes
 - a. stripping instead of burning,
 - b. potential modern incinerators
 - c. industrial areas that guarantees the fulfillment of all occupational and health safety measures in terms, of equipment, employment , and processing.
4. initiating a public awareness about the negative effect of the primitive processing and burning of e-waste on the environment and human health
5. on the further research level
 - investigating in further research the effect of other sources of lead on the future lead concentration in the exposed area.
 - To include children in this future research as they are the most vulnerable sector of the community

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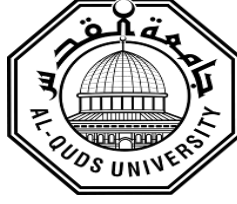
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Appendixes

Appendix 1 (consent form)



استمارة موافقة على المشاركة بالاستبيان

الاسم :

تاريخ الميلاد :/...../.....

عزيزي المشارك

نود دعوتك للمشاركة في هذا البحث والذي يهدف إلى تحديد الأضرار الصحية الناتجة عن حرق النفايات الالكترونية في منطقة جنوب الخليل -بيت عوا- ومدى تأثير حرق هذه النفايات على صحة الإنسان وعلى الموارد الطبيعية في تلك المنطقة (كالمياه). كما وتهدف هذه الدراسة إلى قياس نسبة المواد الثقيلة الناتجة عن حرق هذه النفايات الالكترونية في دم الإنسان وفي مصادر المياه أيضا (كالرصاص) ومدى تأثيرها على صحة الإنسان وتأثيرها على وجود أمراض متعددة قد تؤدي إلى ضرر في صحة الإنسان كالسرطان، فقر الدم، الإجهاد وأمراض متعددة أخرى.

نرجو من حضرتك الموافقة على المشاركة وذلك بإتمام المقابلة والتي تتضمن إجابتك الدقيقة على الأسئلة المطروحة من قبل الباحث. أو من خلال السماح للباحث بأخذ عينات دم أو ماء وذلك من أجل عمل الفحوصات الطبية المخبرية اللازمة لذلك.

نضمن لحضرتك السرية التامة في المعلومات التي ستقدمها للباحث ولك الحرية التامة في عدم ذكر اسمك أو عدم الإجابة على أي سؤال يطرح عليك ولك كامل الحرية في الانسحاب متى شئت من الدراسة وإنهاء المقابلة والمغادرة في أي وقت، دون أي التزام.

سيعرض عليكم الباحث النتائج إذا رغبت في ذلك. إذا كان ليكم أية استفسارات، الرجاء عدم التردد في الاتصال بالباحث.

وبناء عليه أوافق على المشاركة في هذه الدراسة.

توقيع المشارك:

تاريخ الموافقة: شكرا جزيلاً لمشاركتكم.

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Appendix 2 (Questionnaire)

كود البحث.....

1. الاسم..... رقم الهاتف.....

2. العمر.....

3. الجنس ذكر ☐ أنثى ☐

4. نوع العينة: استبيان ☐ دم ☐ مياه ☐

5. صفة المشارك: السكان ☐ العاملين ☐

6. عدد أفراد الأسرة.....

7. البلدة بيت عوا

مكان السكن في البلد شرق ☐ مال ☐ غرب ☐ جنوب ☐ وسط ☐

8. متوسط بعدك عن أقرب مكان حرق (بالمتر).....

10. عدد سنين السكن في البلدة.....

11. عدد مرات الحرق في اليوم.....

12. عدد مرات الحرق في الأسبوع.....

13. هل عملت في حرق النفايات الالكترونية؟ نعم ☐ لا ☐

14. إذا كان جوابك نعم فما هي الفترة وكم عدد السنين التي عملت فيه في حرق

النفايات الالكترونية؟.....

15. ما هو مصدر المياه الرئيسي للمنزل أو المنشأة

مياه البلدية ☐ مياه تجميع المطر ☐ التנקات ☐

16. ما هي نسبة استخدامك لمصادر المياه المذكورة أعلاه خلا العام

مياه البلدية.....% مياه تجميع المطر.....% التנקات.....%

الرقم	تأثير الحرق	اعرض بشدة	أعارض	محايد	موافق	موافق بشدة
1	تأثرت رائحة الهواء من الحرق					
2	تأثر صفاء الجو من الحرق					
3	أثر الحرق على نوعية مياه أبار الجمع في البيوت					
4	أثر الحرق على نسبة تلوث مياه الينابيع					
5	تغير طعم مياه الشرب من حرق النفايات الالكترونية					
6	تغيرت رائحة مياه الشرب من حرق النفايات الالكترونية					